

CLAIMS

1. A molding machine for introducing and compacting molding sand in a mold space for molding a sand mold, comprising:
 - a horizontally fixed pattern plate having a pattern;
 - a vertically movable lower auxiliary frame for surrounding said pattern plate;
 - a vertically movable flask placed above said lower auxiliary frame for surrounding said pattern;
 - a vertically movable filling frame placed above said flask;
 - vertically movable compacting means placed above said filling frame in such a manner that a lower portion of said compacting means is insertable into said filling frame;
 - means for introducing molding sand in a mold space defined by said pattern plate, said lower auxiliary frame, said flask, said filling frame, and said compacting means; wherein said compacting means is lowered to compact the molding sand in said mold space so as to carry out a step of a primary squeeze under a condition where at least said leveling frame cannot be lowered, and is followed by said step of the primary squeeze, said compacting means being lowered to further compact the molding sand in said mold space so as to carry out a step of a second squeeze under a condition where said lower auxiliary frame and said flask can be lowered.
2. The molding machine of claim 1, wherein a force of the compression applied to the molding sand by said compacting means in the second squeeze is greater than that in the primary squeeze.
3. The molding machine of claim 1, wherein said compacting means includes a plurality of squeeze feet for compacting the molding sand, wherein each squeeze foot is independently, vertically, and separately movable.
4. The molding machine of claim 3, wherein a squeeze surface that is defined by all of said squeeze feet has a convex and concave profile during the step in which said mold space is being formed, while it has a planer profile when the squeeze has been completed.

5. The molding machine of claim 1, wherein the rear surface of said compacting means has a flexible membrane on which a compressed fluid is applied.

6. A method for introducing and compacting molding sand in a mold space to mold a sand mold, wherein the mold space is defined by a horizontally fixed pattern plate having a pattern, a vertically movable lower auxiliary frame for surrounding said pattern plate, a vertically movable flask placed above said leveling frame for surrounding the pattern, a vertically movable filling frame placed above said flask, and vertically movable compacting means placed above said filling frame in such a manner that a lower portion of said compacting means is insertable into said filling frame, said method comprising the steps of:

introducing molding sand in the mold space;

lowering said compacting means to compact the molding sand in the mold space so as to carry out a primary squeeze under a condition where at least said lower auxiliary frame cannot be lowered; and

further lowering said compacting means to further compact the molding sand in the mold space so as to carry out a second squeeze under a condition where said lower auxiliary frame and said flask can be lowered.

7. The method of claim 6, wherein a force of the compression applied to the molding sand by said compacting means in the second squeeze is greater than that in the primary squeeze.

8. The method of claim 6, wherein said compacting means includes a plurality of squeeze feet for compacting the molding sand, wherein each squeeze foot is independently, vertically, and separately movable.

9. The method of claim 8, further comprising the steps of:

making a protruding or receding profile of a squeeze surface that is defined by said squeeze feet when the mold space is being formed; and

making a planer profile of the squeeze surface when the squeeze has been completed.

10. The method of claim 6, wherein said introducing step is carried out in such a manner that an airflow of compressed air fluidizes the molding sand to be introduced to the mold space, and an additional airflow of compressed air introduces the fluidized molding sand into the mold space.

11. A method for removing a molded sand mold from a mold space, wherein said mold space for molding a sand mold is defined by a horizontally fixed pattern plate having a pattern, a vertically movable leveling frame for surrounding said pattern plate, a vertically movable flask placed above said lower auxiliary frame for surrounding the pattern, a vertically movable filling frame placed above said flask, and compacting means that is attached to a vertically movable supporting means placed above said filling frame in such a manner that a lower portion of said compacting means is insertable into said filling frame, for a first squeezing and a second squeezing of molding sand that is introduced in the mold space so as to mold the sand mold, said method comprising the steps of:

lifting said leveling frame at a predetermined velocity so as to apply an upwardly-facing force to said supporting means via said filling frame, in this state lifting said flask, which is used to mold the sand mold, said compacting means, and said filling frame in unison so as to separate said flask from said pattern plate; and

removing said separated flask.

12. The method of claim 11, wherein said compacting means includes a plurality of squeeze feet for compacting the molding sand, wherein each squeeze foot is independently, vertically, and separately movable.

13. The method of claim 12, further comprising steps of:

making a protruding or receding profile of a squeeze surface on each of the said squeeze feet, and

making a planer profile of the squeeze surface when the squeeze has been completed.

14. A molding machine, comprising:

a base having a substantially square cross section;

at least three rod-like elements standing on said base, said rod-like elements including at least two upwardly-facing cylinders, each of which has a piston rod;

supporting means secured to the distal ends of said rod-like elements, including the distal ends of said piston rods, said supporting means being vertically movable by operating said cylinders;

a sand hopper mounted on said supporting means, said sand hopper including an aeration means for supplying an airflow of compressed air into said sand hopper so as to fluidize the molding sand therein, and a plurality of nozzles for blowing out the fluidized molding sand by an additional airflow of compressed air;

vertically movable, multi-segmented squeeze feet mounted on the lower portion of said sand hopper at portions adjacent said nozzles, said squeeze feet being located above said base;

a vertically movable, filling frame for surrounding said nozzles and said squeeze feet, said filling frame having vent holes for discharging the compressed air, which is discharged with the molding sand from said nozzles;

carrying means, having a pair of pattern carriers, for alternately moving said pattern carriers in such a manner that one pattern carrier moves to a location aligned with said filling frame above said base, and another pattern carrier moves off therefrom, wherein each pattern carrier carries a corresponding pattern plate having a pattern; and

wherein the molding sand that is discharged from said nozzles is introduced in a mold space defined by said pattern plate, said filling frame, and said squeeze feet, and compacted by said squeeze feet.

15. The molding machine of claim 14, further comprising a vertically movable lower auxiliary frame, which is located above said pattern carrier, for surrounding the periphery of said pattern plate;

16. The molding machine of claim 14, wherein said two upwardly-extending cylinders are arranged on corners of one diagonal line of said base.

17. The molding machine of claim 16, wherein two more upwardly-extending cylinders are arranged on corners of another diagonal line of said base and thus said rod-like elements compose four upwardly-extending cylinders.

18. The molding machine of claim 16, wherein said rod-like elements include a pair of holders arranged on corners of another diagonal line of said base, each holder having a vertically slideable guide pin inserted therein.

19. The molding machine of claim 14, wherein said rod-like elements are three upwardly-extending cylinders arranged to form a triangle on said base, wherein two cylinders are arranged on corners, on the right side or left side of said base.

20. The molding machine of claim 19, wherein said carrying means is a turntable that rotates around the one remaining cylinder, which cylinder forms the axis of rotation of said turntable.

21. The molding machine of claim 14, wherein a squeeze surface that is defined by all of said squeeze feet has a protruding or receding profile during the step in which said mold space is being formed, while it has a planer profile when the squeeze has been completed.

22. A molding machine, comprising:

- a base;
- a vertically movable sand hopper located above said base for containing molding sand therein, said sand hopper including an aeration means for supplying an airflow of compressed air into said sand hopper so as to fluidize the contained molding sand therein, and a plurality of nozzles for discharging the fluidized molding sand by an additional airflow of compressed air;

Partially magnified segment of claim 22 showing a portion of the sand hopper and a portion of the sand hopper of portions adjacent sand nozzles and squeeze feet being ejected above said base.

a vertically movable, filling frame for surrounding said nozzles and said squeeze feet, said filling frame having vent holes for discharging the compressed air, which is discharged with the molding sand from said nozzles;

carrying means, having a pair of pattern carriers, for alternately moving said pattern carriers in such a manner that one pattern carrier moves to a location aligned with said filling frame above said base, and the other pattern carrier moves off therefrom, wherein each pattern carrier carries a corresponding pattern plate having a pattern;

a vertically movable flask for surrounding said pattern of said pattern plate;

a vertically movable lower auxiliary frame for surrounding the periphery of said pattern plate;

means for lowering said squeeze feet toward said pattern plate so that said squeeze feet apply a first squeeze to the molding sand that is discharged from said nozzles and introduced in a mold space, which is defined by said pattern plate, said filling frame, said flask, said lower auxiliary frame, and said squeeze feet; and

means for lowering said filling frame, said flask, said lower auxiliary frame, and said squeeze feet in unison toward said pattern plate so that said squeeze feet apply a second squeeze to the molding sand, and for lifting said filling frame, said flask, said lower auxiliary frame, and said squeeze feet in unison, so as to pull up the molded sand mold.

23. The molding machine of claim 22, further comprising means for preventing any undesirable motion of said flask so as to keep the sand mold horizontal.

24. The molding machine of claim 14, wherein a squeeze surface that is defined by all of said squeeze feet has a protruding or receding profile during the step in which said mold space is being formed, while it has a planer profile when the squeeze has been completed.

25. A method for molding a sand mold from molding sand that is introduced in a mold space, wherein the mold space is defined by a horizontally fixed pattern plate having a pattern, a vertically movable lower auxiliary frame for surrounding said pattern plate, a

vertically movable flask placed above said leveling frame for surrounding the pattern, a vertically movable filling frame placed above said flask, and vertically movable, multi-segmented squeeze feet placed above said flask so that said squeeze feet are insertable into said filling frame, said method comprising the steps of:

supplying an airflow of compressed air to molding sand to be introduced into the mold space so as to fluidize the molding sand, and supplying an additional airflow of compressed air to the fluidized molding sand so as to introduce the fluidized molding sand into the mold space;

lowering said squeeze feet toward said pattern plate in such a manner that said squeeze feet apply a primary squeeze to the introduced molding sand in the mold space;

lowering said filling frame, said flask, said lower auxiliary frame, and said squeeze feet in unison toward said pattern plate in such a manner that said squeeze feet apply a second squeeze to the molding sand; and

lifting said filling frame, said flask, said lower auxiliary frame, and said squeeze feet in unison so as to remove the sand mold.

26. The method of claim 25, wherein said removing step includes a step for preventing any undesirable motion of said flask so as to keep the sand mold horizontal.

27. The method of claim 25, further comprising the steps of:

making a protruding or receding profile of a squeeze surface that is defined by said squeeze feet when the mold space is being formed; and

making a planer profile of the squeeze surface when the squeeze has been completed.